BACTERIOLOGICAL WATER QUALITY OF LOVESICK, CLEAR AND STONY LAKES

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Abstract

During the summer of 1970, three intensive bacteriological surveys were carried out to determine the water quality of Stony, Clear and Lovesick Lakes in the Kawartha Lakes region. The results of these surveys were treated statistically and were compared with the OWRC recreational water quality criteria (a geometric mean of 1000 total coliforms/100 ml, 100 fecal coliforms/100 ml and 20 fecal streptococci/100 ml). These surveys showed that during the mid-summer season, Lovesick Lake was polluted with fecal material to the point of making the lake unsuitable for body contact recreational use.

Similarly, the upper section of Clear Lake, just downstream from Burleigh Falls was impaired for body contact recreational use.

Stony Lake water quality over the summer was influenced by the inflow of large quantities of natural animal pollution from Eels Creek, Jack Creek and Julia Creek. During the mid-summer season, the fecal pollution did not reach the point at which recreational use should have been restricted. However, bacterial results were sufficiently high and variable to warrant caution in the use of the water of Stony Lake for recreational purposes. On the basis of fecal coliforms, water in the area of McCrackens Landing (115 to 173/100 ml) was unsuitable for recreational purposes.

TABLE I - Mid-Summer Bacterial Levels in Stony, Clear and Lovesick Lakes

LAKE	PARAMETER	LEVELS (Geometric Mean/100 ml)
Lovesick	Total Coliform	1000 to 2000
	Fecal Coliform	40 to 140*
	Fecal Streptococcus	7 to 89
Upper Section of Clear Lake	Total Coliform	920 to 2600
	Fecal Coliform	70 to 130
	Fecal Streptococcus	10 to 210
Stony	Total Coliform	300 to 800
	Fecal Coliform	2 to 65*
	Fecal Streptococcus	1 to 30

* with large fluctuations of daily counts.

At no time during the summer was the water of Clear Lake between Hell's Gate and Young's Point polluted to the point of requiring restriction of its use.

Both the pre-season and post-season surveys of these lakes showed that the lakes recovered rapidly from the pollution load imposed on them by increased human activity during the summer.

Introduction:

Throughout the summer of 1970, a series of intensive bacteriological surveys of three Kawartha Lakes - Stony, Clear and Lovesick Lakes - located in the County of Peterborough, were undertaken. A preliminary (PRELIM) survey was conducted, followed by three intensive surveys designated:
Pre-season (PRE), mid-season (MID) and post-season (POST). A summary of the surveys, dates, number of stations sampled and the number of samplings per station is presented in Table II. Surveys PRE, MID and POST were of eleven-day duration in order to include two weekends within the survey.

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TABLE II - Survey Information

Survey	Date	No. of Stations		Number of Days Sampling to Number of Stations
		Surface	Depth	
PRELIM	June 3, 4 & 5, 1970	175	-	2 visits to 11 stations 1 visit to the remainder
PRE	June 19 - 29, 1970	84	6	11 visits to 25 stations 5-7 visits to the remainder
MID	July 31 - August 10, 1970	84	6	11 visits to 32 stations 5-7 visits to the remainder
POST	September 11 - 21, 1970	72	4	11 visits to 21 stations 3-6 visits to the remainder

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METHODS:

The surface samples were taken in sterile 250 ml autoclavable polycarbonate bottles from approximately one metre below the water surface. Depth samples were taken using sterile 237 ml air syringes employing a modified "piggy back" sampler. All samples from the intensive surveys were analyzed bacteriologically for total coliform (TC), fecal coliform (FC) and fecal streptococcus (FS), usually 2 to 6 hours after sampling. Analyses were performed using the membrane filter technique as specified in "Standard Methods for the Examination of Water and Wastewater", twelfth edition 1965, APHA, AWWA, WPCF. The only modification was the use of MacConkey MF broth in the FC analysis. Samples from the PRELIM survey were analyzed only for TC.

Statistical evaluation of the results of the surveys was based on the geometric means of the bacterial counts obtained at stations during the survey. In the statistical analysis of the means, a mean for a station was compared with those of all the other stations on the lake. This comparison was accomplished by graphically comparing the geometric means and 95% confidence limits on the means. In this method, if the confidence limits of two means did not overlap, the two means were significantly different from each other.

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If the confidence limits of two means overlapped with neither mean included in the overlap, usually the means were significantly different. In all other cases of overlap there was no significant difference between the means. Comparison of means between stations in one survey, and comparison of means for each of the same stations for the three surveys, allowed trends to be determined which facilitated statistical interpolation between stations and surveys. Each station's results were important only as a part of the whole picture.

Simultaneously all means were compared to the water quality criteria for total body contact recreation as set forth by the OWRC in "Guidelines and Criteria for Water Quality Management in Ontario" (June 1970).

All bacterial concentrations stated in the following report are geometric means of the observations of a survey, except where otherwise specified.

DISCUSSION AND RESULTS:

The following were the major geographical factors affecting the bacteriological quality of these lakes that:

(1) Clear and Lovesick Lakes form a shallow "flow through" portion of the Trent system which receives water from the upstream watershed.

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(2) Numerous dams and lakes artificially hold back the water in the Trent system.

(3) The shores and shallows in many areas are swampy and overgrown, especially in mid-summer.

(4) Stony Lake is a secondary receiving basin for another watershed and flows into Clear Lake through a wide island strewn mouth.

(5) The water of these three lakes exits through the river, lock and dam complex at Young's Point.

LOVESICK LAKE:

Lovesick Lake, that small shallow lake lying between Lock 30 and Lock 28 (Burleigh Falls) on the Trent Canal system, receives water from Lower Buckhorn Lake via five small dams and the lock. The lake empties into Clear Lake via dams at Parry's Creek, and at Burleigh Falls, and Lock 28. Most of the lake except the canal channel is less than 10 feet deep. In the three intensive surveys, Lovesick Lake was sampled at 12 surface stations (72 through 83) and one depth station (76D). Of major interest were station 78 located at Lock 30 from Lower Buckhorn Lake, stations 77 and 79 which represented the two other major outflows of Lower Buckhorn Lake, station 76 located in the middle of the channel and the lake, and station 83 located above Lock 28 at Burleigh Falls. The other stations were located along the shore and were numbered in clockwise fashion.

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In the PRELIM survey, all twenty stations showed low TC counts (0 to 82/100 ml). During the PRE survey these counts changed very little. All stations gave geometric mean counts of 25 to 60 TC/100 ml, 3 to 12 FC/100 ml and 2 to 9 FS/100 ml. The main deviations from this average condition appeared with the FS, where significantly higher means occurred at stations 73 (10/100 ml), 77 (9/100 ml) and 82 (21/100 ml). These higher FS means were probably due to a natural (animal) pollution source at or near these stations.

In the MID survey, all the TC and many of the FC and FS means increased significantly. In mid-summer, the TC means (1000 to 2000/100 ml) exceeded the OWRC recreational water criteria and no station was significantly different from any other. The FC counts at all stations varied widely with time. The means of these counts presented the pattern that stations 72, 73 and 74 were at or near the 100 FC/100 ml criteria. Station 77 was above the acceptable limit (143 FC/100 ml) and the remaining stations showed less than 60 FC/100 ml.

The FS counts, although not as variable with time, showed a greater variation with stations. At stations 78, 79 and 82, the FS means were above the 20/100 ml level, with mean concentrations of 30/100 ml, 27/100 ml and 89/100 ml respectively. Station 82 was significantly higher than the other stations

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during the MID survey. This supports earlier findings about station 82. All the remaining stations had FS means lower than the objective except these stations near the northern shore which tended to be higher. This pattern of results indicated that the water of Lovesick Lake at the time of the MID survey tended toward a polluted situation which was unacceptable for recreational purposes.

Water along the southern shore (stations 73, 74 and 75), was contaminated showing high TC, high FC and lower FS means which indicated a human fecal pollution source. Station 77 was particularly bad but since there were fewer cottages nearby, this may have been due to a pollution contribution from Lower Buckhorn Lake. By comparison, stations 79 through 83, on the northern shore, were in better condition with the increase in FS showing a possibly higher incidence of pollution from natural animal sources. The FC were widely variable in this section making it unacceptable for recreational purposes. This pollution was probably influenced by heavy rains at the beginning of the survey, but the counts were also high on the second weekend of the survey when meteorological influences were minimal.

The pattern in the POST survey differed from that presented in either of the previous surveys. At this time, TC were high (means of 600 to 3500/100 ml), generally above the

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recreational criteria, and increasingly variable. However, FC were very low (means between 2 and 10/100 ml) and FS were also low (means of 2 to 8/100 ml), with slightly higher means at stations 78 (11/100 ml) and 82 (13/100 ml). This pattern was indicative of a water which was polluted, but subsequently the fecal contamination input was decreased or eliminated. The TC organisms were continuing to multiply, but the more sensitive FC indicator had all but been eliminated.

Lovesick Lake was fecally polluted during the peak population summer season sufficient to restrict its use for recreational activities. Bacteriologically, the water had recovered following the summer cottage season.

UPPER SECTION OF CLEAR LAKE:

The upper section of Clear Lake between Burleigh Falls and Hell's Gate is, to a large degree, a wide (1000 to 2000 feet) deep river which terminates in a series of small islands where Stony and Clear Lakes meet. The north shore of the terminal portion contains a wide area of shallow water, fouls and swamp. This section of the lake was sampled at stations 1 through 12. Station 2 was the outflow of Lovesick Lake, stations 4, 5 and 6, a range near the middle of the section of the lake and station 12, in the channel at Hell's Gate.

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During the PRELIM survey the TC counts from this upper section of Clear Lake were low (2 to 36/100 ml). In the PRE survey the TC levels were also low (geometric means of 35 to 80/100 ml). However, the variation from station to station was very small. The FC means, at this time, were at levels between 4 and 20 FC/100 ml, and tended to decrease from station 2 toward station 12.

The FS means were highly variable (10 to 90/100 ml). The means at stations 2 (69/100 ml), 10 (90/100 ml) and 11 (79/100 ml) were higher, and in some cases significantly higher than those at the other stations.

During the MID survey the stations on this section of the lake had TC levels above the suggested criteria. A significant decreasing tendency in TC levels, from station 2 (2600 TC/100 ml) through to station 12 (917 TC/100 ml) was in evidence.

The FC means, however, maintained a constant level of 70 to 130/100 ml with only stations 10, 11 and 12 being lower (20 to 40/100 ml). The FS showed a significant decrease in means with distance from station 2 (210 FS/100 ml) through the mid-section range (30 to 56 FS/100 ml) toward station 12 (4 FS/100 ml).

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During the POST survey, TC means at stations 1 to 6 and 12 were high (1600 to 2500 TC/100 ml), and were above the recreational use guideline of 1000 TC/100 ml. At stations 7 to 11, the TC levels were lower (400 to 920/100 ml). However, the FC levels had decreased significantly from the MID survey level, to 3 to 20 FC/100 ml. The FS, again, as in the MID survey, showed a significant decrease with distance from station 2 (86 FS/100 ml) through the mid-section range (8 to 13 FS/100 ml) to station 12 (2 FS/100 ml).

The pattern of observations shown in this upper section of Clear Lake indicated an increase in fecal pollution in the mid-summer season to the point of impairing the water quality for recreational uses. The lake, however, recovered to an acceptable level as the summer population decreased (POST survey). The main sources of fecal pollution were in and around the Burleigh Falls area, with a major contribution from the outflow of Lovesick Lake (station 2). However, the cottages of the area were also contributing to the problem since the FC levels were maintained for some distance downstream. The recreational use of this section of Clear Lake was therefore restricted by fecal contamination from two main sources, Lovesick Lake and the cottages.

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STONY LAKE

Stony Lake, which may have received its name from the innumerable rocky islands, is the deepest of the three lakes covered in this report. The lake receives water from Eels Creek (station 49), Jack Creek, which passes through the Village of Stonyridge (station 51), Julia Creek (station 56), and the Indian River and Dummer Lake (station 64). Located on the lake are an older cottage development in the area of Crowes' Landing (stations 57 to 61), a developed area around McCrackens' Landing (stations 68, 69 and 70) and a third area of development around Mount Julian (station 37). The lake empties into Clear Lake by a wide island strewn mouth in the region of Hell's Gate and Juniper Island.

Three sampling ranges were set up, stations 37 to 40 running from Mount Julian to the east end of Eagle Mount Island, stations 66 to 68 running from the west end of Eagle Mount Island to McCrackens' Landing and stations 43 to 45 at a narrowing east of Northey Bay.

In the PRELIM survey, the TC counts for samples taken from Stony Lake were low (0 to 44/100 ml) with Stonyridge (station 51) and a station near McCrackens' Landing, being the highest at 44/100 ml. During the PRE survey, TC means were not

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much higher (15 to 100/100 ml) but did show the trend of being lower at the eastern end of the lake and higher at the western end (Mount Julian and McCrackens' Landing). Only the inflow of Eels Creek (station 49), 75 TC/100 ml, Jack Creek (station 51), 144 TC/100 ml and Julia Creek (station 56), 55 TC/100 ml, marred this trend. FC were uniformly low (1 to 6/100 ml) again with higher means at the inflowing streams, Eels Creek (12/100 ml), Jack Creek (93/100 ml), Julia Creek (8/100 ml) and Indian River (11/100 ml). The FS means presented a completely different pattern. The stations on the north shore, with the exception of 36, were significantly lower than the stations on the south shore. But even in this situation, peaks at inflowing streams could be discerned. The north shore stations had means in the range 1 to 5 FS/100 ml with station 36 at 24/100 ml and Eels Creek at 19/100 ml. Jack Creek again was significantly high with 95 FS/100 ml. The south shore had means in the range 9 to 30 FS per 100 ml. However, stations 65, 66 and 67 between the Indian River and McCrackens' Landing were more like the north shore with lower FS means (1 to 2/100 ml).

During the MID survey, the TC means for Stony Lake were uniform between 300 and 800 TC/100 ml with no discernable trends. Eels Creek and Jack Creek were significantly higher at 2,170 and 2,390 TC/100 ml respectively, which is above the recreational use

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criteria of 1000 TC/100 ml. FC counts varied widely with time, with most stations showing both low counts and counts in the 200 to 500/100 ml range. Trends of means were not visible, with most stations between 2 and 65 FC/100 ml. Jack Creek (176/100 ml), and the region around McCrackens' Landing (115 to 173/100 ml) had FC levels greater than the recreational objective of 100 FC per 100 ml, and significantly greater than those at the other stations. Again, as in the PRE survey, the FS levels presented a north-south split with stations 61 through 67 being as low as those on the north shore. At the north shore stations, FS levels ranged from 1 to 4/100 ml. The south shore which in this case included stations 56 to 60 and 68 to 70, had a FS level of 8 to 30/100 ml. Jack Creek was significantly high at 388 FS per 100 ml. Eels Creek (at 18 FS/100 ml) was higher than other stations in the region.

During the POST survey, the TC level was significantly higher in the Mount Julian range (stations 37 to 40) at 1030 to 2300 TC/100 ml, and in the McCrackens' Landing range (stations 66 to 68) at 840 to 1370 TC/100 ml, than the lake in general which showed 100 to 500 TC/100 ml. Jack Creek again was significantly higher than the norm at 820 TC/100 ml, and Eels Creek was slighly higher (430/100 ml). FC levels were low (1 to 10 FC/100 ml) with Jack Creek being higher at 16/100 ml.

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FS levels were similarly low (1 to 10/100 ml) with the higher levels occurring at the eastern end of the lake. The FS level at Jack Creek (350/100 ml) was signigicantly higher than that at any other station during the POST survey of Stony, Clear and Lovesick Lakes.

From the above summary of the surveys of Stony Lake, the main influencing factors were the inflowing three streams and occasionally the Indian River. At no time during the surveys did the bacterial levels exceed the recreational water quality criteria except at the inflows of Jack and Eels Creeks and during the POST survey at the Mount Julian and McCrackens' Landing ranges. In the latter of these exceptions, only the TC objective was exceeded. All other indicator levels were quite low. The pattern of the results for the rest of the lake indicated that the lake was being flushed out and the high levels at these ranges were merely the residual pollution.

During the mid-summer season, the average water quality was acceptable. However, because of the fluctuations in FC counts, at particular times individual stations may, for short periods, exceed safe use levels. The steady state of high FS levels in the region of stations 56 to 60 (Crowes' Landing) may be indicative of a continuous low level of fecal contamination of this section of the lake from the older cottage development.

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However, this contamination was not apparent from the other parameters and may require further investigation.

The contamination entering the lake with the inflowing streams was apparently of animal origin since, although FC levels were high, FS levels were even higher.

Thus with the exception presented by the wide fluctuation in FC during mid-summer, Stony Lake was acceptable according to present guidelines for recreational use purposes.

LOWER SECTION OF CLEAR LAKE:

The lower section of Clear Lake consists of the body of water extending from the island complex in the region of Hell's Gate southward to Young's Point and Lock 27 of the Trent Canal system. The lake receives water from few major streams other than the flow from Stony Lake and the flow from Lovesick Lake via the upper section of Clear Lake and empties through the lock and dam complex at Young's Point. The eastern shoreline consists of limestone cliffs. Shallow water areas are limited in extent except among the islands at the north end of the lake. Cottage development is scattered along the shore with no major centres except for the South Beach area near Young's Point.

The lake was sampled in the pattern of four ranges located at intervals down the flow. Stations 14 to 17 (range I) were located to determine the quality of water throughout the island

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complex. Stations 20 to 22 (range II) formed a range one third of the way down the flow at Sandy Point. Stations 25 to 28 (range III) formed the third range at the two thirds mark. The fourth range (range IV) stretched across the outflow of the lake from South Beach (stations 31 to 34).

During the PRELIM survey of Clear Lake, the TC counts were low (1 to 28/100 ml). The TC counts in the PRE survey increased to give geometric means of 50 to 160 TC/100 ml which were still well within acceptable levels. The TC concentrations tended to increase in the direction of flow with range I having means of 50 to 70 TC/100 ml and range IV having means of 110 to 160 TC/100 ml. Both FC and FS levels were 1 to 5 organisms per 100 ml with stations 13 and 14 being the only exception, showing 10 and 11 FC/100 ml and 15 and 18 FS/100 ml respectively.

During the MID survey, TC, FC and FS levels were all below the recreational use criteria at 150 to 990 TC/100 ml, 11 to 65 FC/100 ml and 1 to 10 FS/100 ml. The only trend which appeared was one of higher bacterial levels at the inshore stations and lower levels at the mid-lake stations.

During the POST survey, TC levels increased over the MID survey to above the acceptable concentrations at 840 to 1920 TC per 100 ml. But both FC and FS levels were low at 1 to 10 bacteria per 100 ml.

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With the exception of the TC levels in the POST survey, bacterial parameters never exceeded the recreational use objectives. The increased level of TC in the POST survey may represent a buildup of TC as the lakes and streams upstream were washed out. This theory is compatible with the observation of bacterial levels in both Stony and the upper section of Clear Lake during the same survey. The water of Clear Lake was therefore suitable for recreational use during most of the summer.

DEPTH STATIONS:

During the three intensive surveys there were six depth stations which were sampled.

Station	Location	Depth
SC 21D	Range II of Clear Lake at the centre of the channel.	30 feet
SC 38D	Range of Mount Julian.	30 feet
SC 44D	Range across Stony Lake near Northey Bay.	40 feet
SC 60A	Middle of Stony Lake off Eels Creek.	40 feet
SC 60B	West of Eels Creek outflow.	40 feet
SC 76D	Middle of Lovesick Lake in channel.	25 feet

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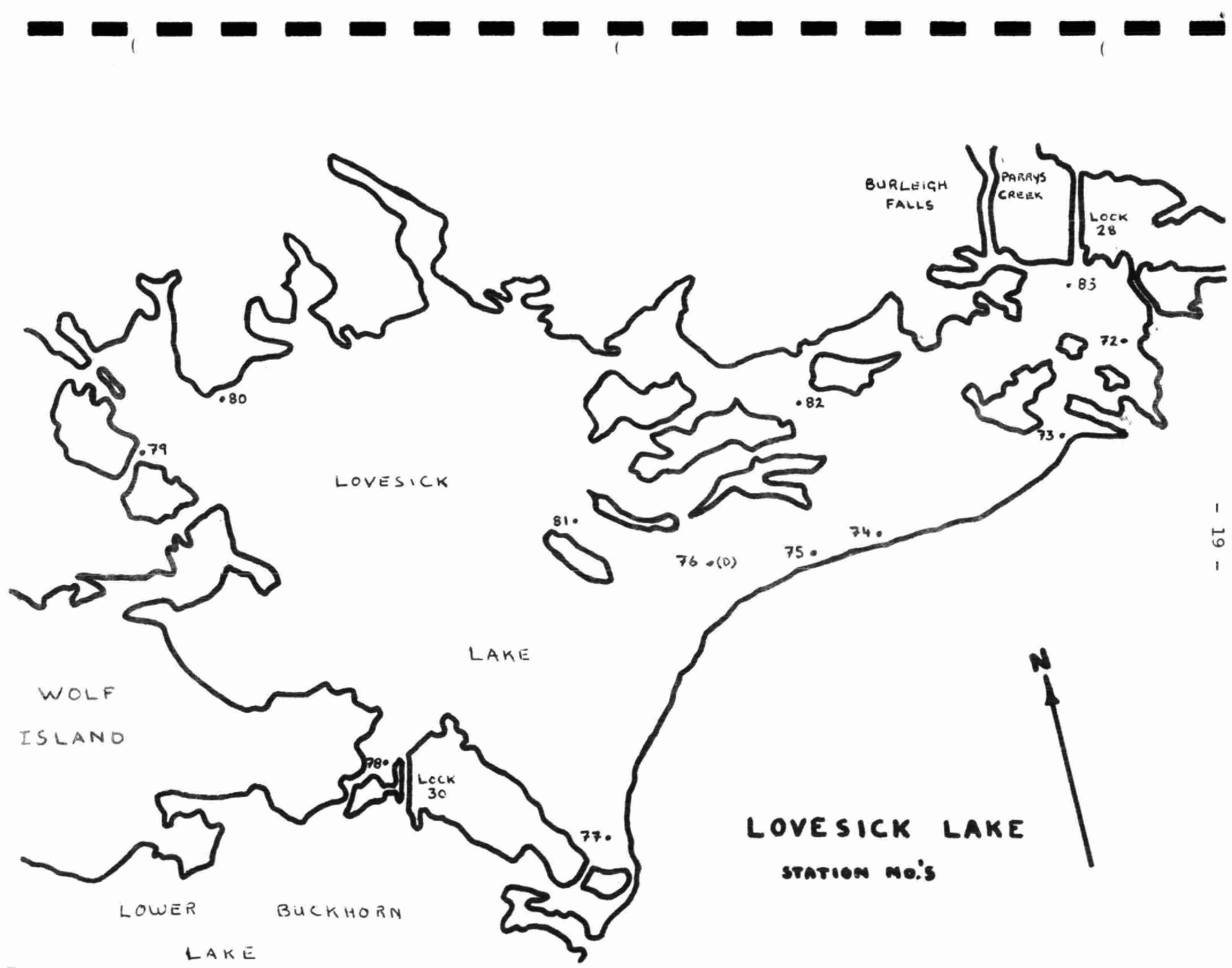
Except for the MID survey, station 21D total coliforms and fecal streptococci, station 38D fecal coliforms, the bacterial levels at all of the depth stations during all three surveys were identical to those found at the corresponding surface stations. In the case of the exceptions the bacterial level was always lower at the depth station. These observations indicate that the influence of a thermal barrier was minimal. These stations did not reveal any additional information about the general pollution levels in the lakes.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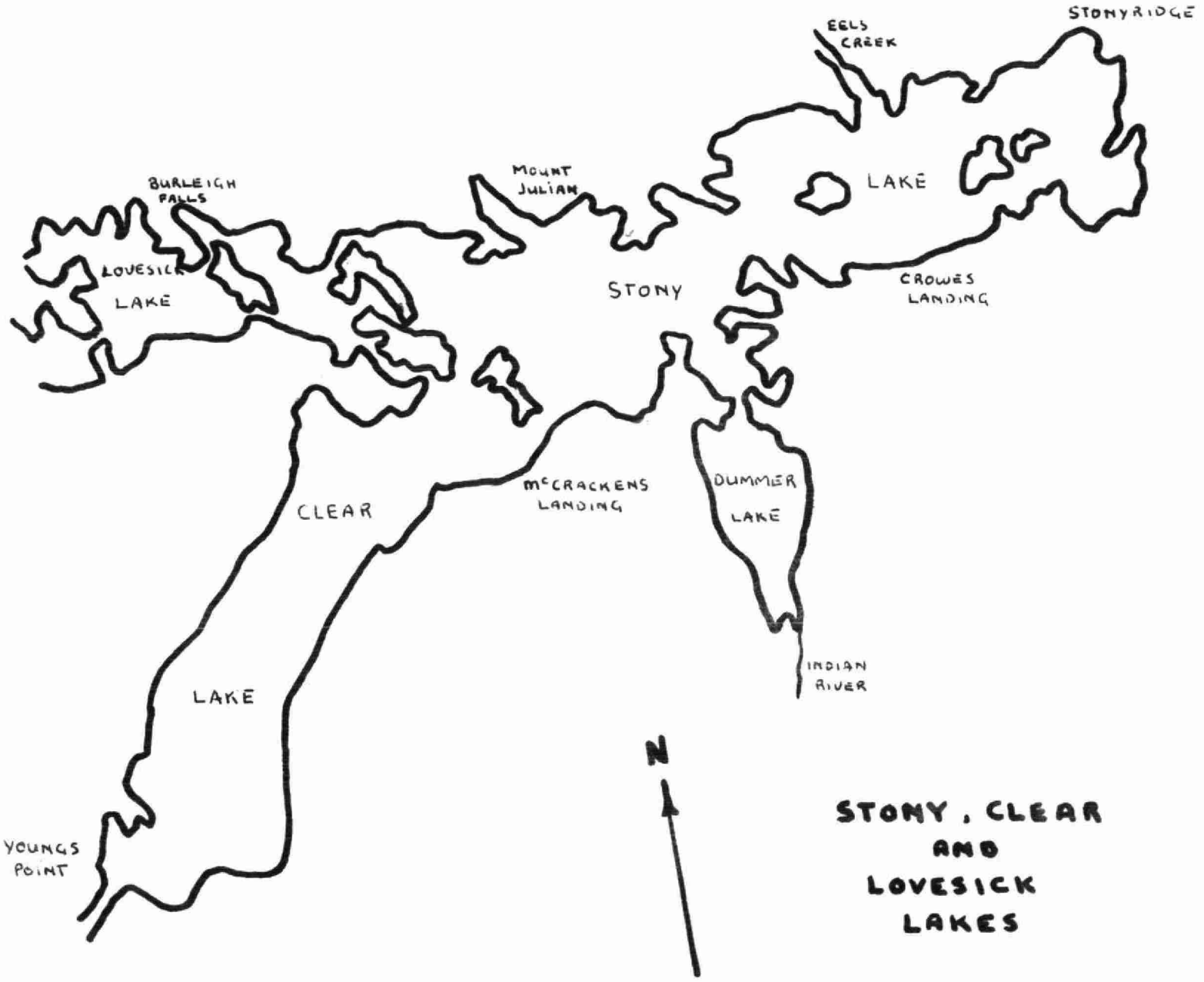

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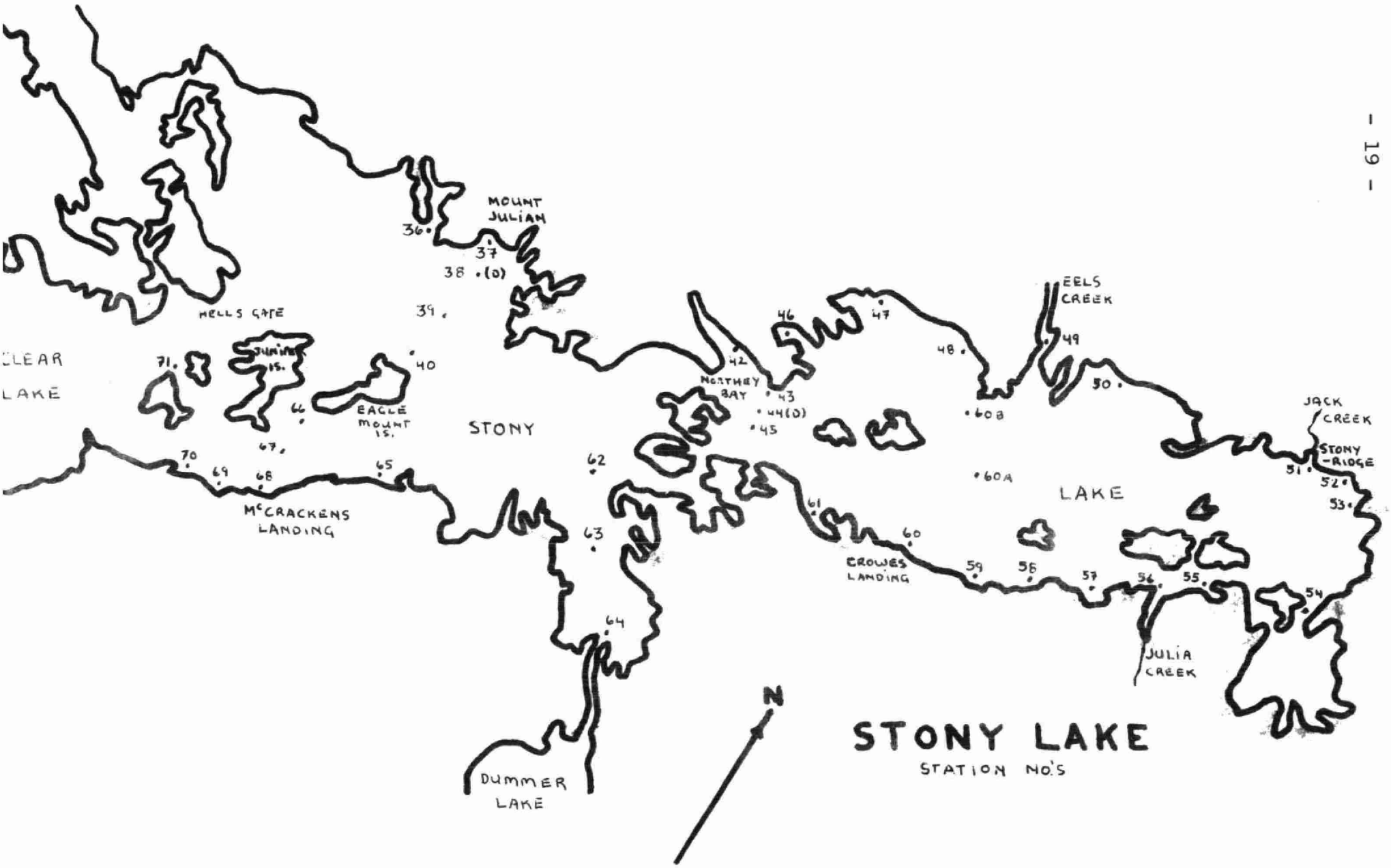
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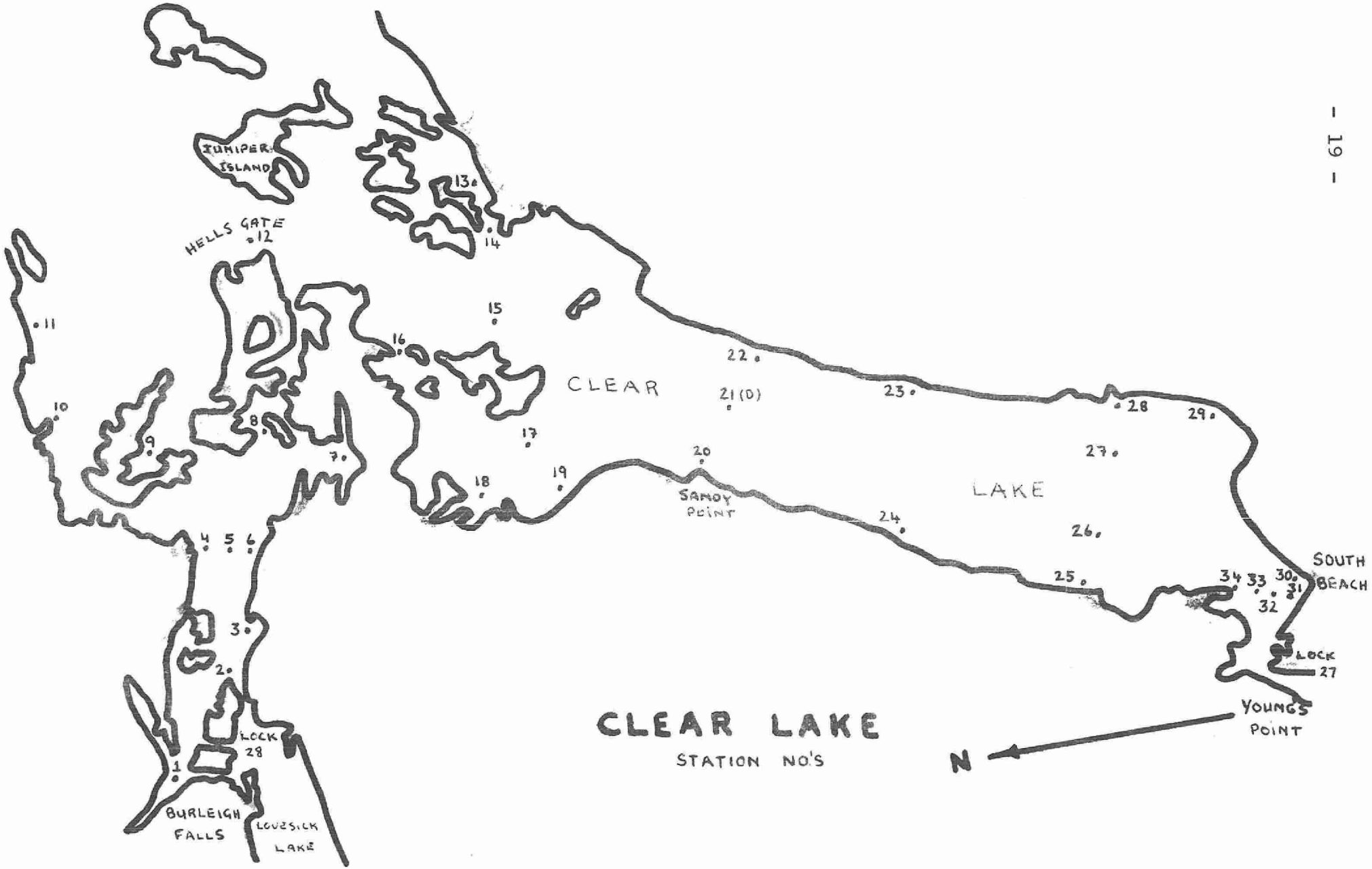
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